Remarks

1. Claims 1, 2, 5, 7, 8 and 10 are pending. Claims 1 and 10 are presently amended. Claims 3, 4, 6, 9, and 11-17 are cancelled.

2. Claims 1, 2, 5, 7, 8, and 10 are presently rejected under 35 U.S.C. §112, first paragraph, for failure to comply with the enablement requirement. In summary, the examiner has indicated that the claims contain subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

The examiner indicates that the process of predicting the properties of slag produced during the refining of the silicon metalloid based on equilibrium calculation is not enabled. The disclosure does not contain an adequate description of how the slag properties are predicted. While the disclosure states that the method of predicting the slag properties is known in the art, the examiner indicates that no evidence has been provided that one skilled in the art at the time of the invention would be able to predict the properties of the slag produced during the refining of the silicon based on the information provided in the disclosure of the invention without undue experimentation.

The examiner then directs the enablement analysis to the eight factors outlined in In re Wands, 8 USPQ 1400 (CAFC 1988) at 1404, for determining whether a disclosure would have required undue experimentation. Citing Ex parte Forman, 230 USPQ 546 (BdApls) at 547, the examiner recited the eight factors the court outlined and applied them to the present case as follows:

1) The nature of the invention:

The instant invention is related to a process of selecting/producing silicon for use in the direct process synthesis of organohalosilanes by predicting the properties of the slag that will be produced while refining the silicon metalloid.

2) The relative skill in the art:

The examiner determined the level of skill in the art to be high.

3) The state of the prior art:

The examiner found no evidence in the prior art for a method of predicting the properties of slag that is formed when silicon is refined based on the impurities present in the silicon metalloid prior to refinement.

4) The predictability of the art:

The examiner found that the art is not highly predictable, as different lots of chemical grade silicon react differently in the direct process. The examiner stated that efforts have been made in the past to predict the behavior of the lots based on the contaminants present in the silicon, but these efforts, while affording a degree of control, have not been entirely successful as admitted in the disclosure.

5) The breadth of the claims:

The examiner states that applicant's assertion that the slag properties may be predicted from the elemental impurity levels and process conditions is not commensurate with the scope of the enablement provided in the disclosure.

6) The amount of guidance presented:

The examiner finds that no guidance is provided in the disclosure as to how the slag properties are actually predicted. The statement that the prediction of the properties is reached through the use of equilibrium equations and data is not sufficient to allow one skilled in the art to accurately predict the slag properties. The specific equations and data used to formulate the prediction are not disclosed.

7) The presence or absence of working examples:

The examples provided in the specification provide predicted slag property values, but fail to disclose the manner in which the predicted values are ascertained. With no disclosure of the actual prediction process it would not be possible for one skilled in the art to reproduce the predicted values.

8) Quantization of undue experimentation:

The lack of sufficient teaching and guidance in the disclosure as to the way in which the slag properties are predicted would prevent one skilled in the art from practicing the process of the present invention without conducting undue experimentation.

Applicant disagrees with the conclusions for factors 3, 5, 6, 7, and 8. Applicant asserts that one skilled in the art would be able to practice the invention as claimed based upon the disclosure. That is, one skilled in the art would be able to practice the process step of predicting the properties of slag produced during refining of the silicon metalloid based on equilibrium calculation using the elemental impurity levels and the measured temperatures of the batch of silicon metalloid without undue experimentation.

First, it was known in the art that once the elemental impurities of a batch of silicon metalloid are determined, the slag composition can be determined based upon equilibrium calculations as claimed in claim 1 and described at paragraph [0015]. As indicated in the enclosed affidavit of Dr. Dosaj, these equilibrium calculations are known in the art and have been published along with the relationship of the aluminum and calcium impurity levels to slag composition. For example, the relationship between the elemental impurities in silicon metalloid and slag composition was described in June 1992 in the journal article "Principles of Silicon Refining", by Tuset et al., published in Silicon for Chemical Industry (attached as Exhibit A). Equations (3) and (4) on page 3 of Tuset copied below show the distribution equilibria in silicon oxidative refining:

$$Al + \tfrac{3}{4}(SiO_2) = 3/4Si + \tfrac{1}{2}(Al_2O_3) \qquad (3)$$

$$Ca + \tfrac{1}{2}(SiO_2) = \tfrac{1}{2}Si + (CaO) \qquad (4)$$

From these equations, the equilibrium concentrations are determined based on basic physical chemistry. For example, the equilibrium between Si, Al, SiO_2 and Al_2O_3 from equation (3) above can be expressed by in terms of the activities and the equilibrium constant:

$$K = [a_{Si}]^3\,[a_{Al2O3}]^2 / [a_{Al}]^4\,[a_{SiO2}]^3$$

Based on these fundamental equations and experimental data, the relationship between the slag composition and Ca and Al impurities can be plotted. For example, the ternary diagram

in Figure 5 on page 6 of Tuset is a plot of the isoconcentrational lines for Ca and Al in relation to the composition of the slag in terms of weight of SiO_2, Al_2O_3, and CaO at equilibrium conditions. As indicated in the affidavit of Dr. Dosaj, this ternary diagram in Tuset is related to actual slag compositions at specific process conditions for silicon metalloid by the use in the equilibrium calculations of activity coefficients measured at the specific refining temperature conditions for Al and Ca. The activities of SiO_2, Al_2O_3, and CaO compositions at various process temperatures are also known from Figures 4, 5, 7, and 8 in "Activities in the Liquid Solution SiO_2-CaO-MgO-Al_2O_3 at 1600°C" by Richard H. Rein and John Chipman published in Transaction of the Metallurgical Society of AIME 233 (1965), 415 (attached as Exhibit B) and figures 6, 7, and 8 in "Critical Evaluation and Optimization of the Thermodynamic Properties and Phase Diagrams of the CaO-Al_2O_3, Al_2O_3-SiO_2, and CaO-Al_2O_3-SiO_2" by Gunnar Eriksson and Arthur D. Pelton, published in Metallurgical Transactions B 24B (1993), 807-814 (attached as Exhibit C).

Therefore, as in in the affidavit of Dr. Dosaj, the composition of SiO_2, Al_2O_3, and CaO slag can be calculated at equilibrium from the Al and Ca impurity levels measured in the silicon metalloid using a ternary diagram such as the one in Figure 5 of Tuset. Once the slag composition is known, the properties of the slag can be predicted from known relationships between slag composition and slag properties.

As indicated in the affidavit of Dr. Dosaj, the slag properties of a given composition may be predicted at a given temperature using the relationships described in the following references in the public domain and readily apparent to one skilled in the art at the time of filing:

- Kammel, Von Roland; Winterhager, Helmut Z. Erzbergbau Metallhuettenw, 18 (1965), 917 (attached as Exhibit D);
- Kawai, Y.; and Shiraishi, Y. Handbook of Physico-chemical Properties at High Temperatures (1989), Table 4-16, page 131 (citing Kozakevitch, P. Rev. Metall., Paris, 57 (1960), 149 (attached as Exhibit E) (citing Machin, J.S.; Yee, T.B.; and Hanna, D.C. J. Am. Ceram. Soc., 35 (1952), 322) and Kozakevitch, P. Rev. Metall. Paris 57(1960), 149; and

- Levin, Ernest M.; Robbins, Carl R.; and McMurdie "Phase Diagrams for Ceramists: Volume I American Ceramic Society, 1964, Figure 630 (attached as Exhibit F).

Table 1 and 2 of Kammel show the relationship between slag composition and density, Kawai describes the relationship with viscosity in the tables on pg. 131, and Figure 630 of Levin shows the relationship between slag composition and melting point. Therefore, the relationship between slag properties based on slag composition was in the public domain and would have been readily apparent to one skilled in the art.

Thus, one skilled in the art would be able, based upon the description in applicants specification, to determine the slag composition of a given batch of silicon metalloid based upon the level of Ca and Al impurities at equilibrium based upon the equilibrium equations/calculations known in the art. Once this slag composition is determined, one skilled in the art would be able to predict the density, viscosity, and melting point of the slag from published data readily available and apparent to one skilled in the art. Once these slag properties are determined, one skilled in the art would be able to select an appropriate batch of refined silicon that will perform in the direct process using the limits claimed and described in the applicant's specification.

Turning to factors 3, 5-8 from In re Wands, applicant asserts that the analysis of these factors does not lead to a finding that undue experimentation is required to practice the invention. First, with respect to factor 3, prior art submitted with the affidavit of Dr. Dosaj clearly shows that there is ample evidence of the predictability of slag composition from Al and Ca impurity levels in the art.

For factor 5, the pending claims are limited in breadth by the predicted slag density, viscosity and melting point in relation to the refining temperature. They are limited in that the predicted slag density is at least 0.02 gram per cm^3 higher than the density of the batch of chemical grade silicon at the casting temperature, the predicted slag viscosity is at least 35 poise at the casting temperature, and the predicted melting point of the slag is lower than the temperature during refining of the batch of chemical grade silicon. Since the determination of slag composition and properties from the Al and Ca impurities in the silicon metalloid would

have been known to one skilled in the art, and the methods of determining the Al and Ca impurities was described in the specification and would also have been known to one skilled, the claims as are enabled commensurate with the their scope.

For factor 6, the relationship between Al and Ca impurities in silicon metalloid at equilibrium conditions and slag composition was published and would have been known to one skilled in the art as evidenced by the affidavit of Dr. Dosaj. The relationship between slag composition and slag properties was also known in the art as is demonstrated in the Exhibits. Guidance is provided in the specification for determining Al and Ca impurity levels and for selecting a silicon metalloid based upon the predicted slag viscosity, density, and melting point. Thus, there us adequate guidance provided to one skilled in the art to practice the invention. One skilled in the art is taught to determine the Al and Ca impurity levels and would know how those impurity levels are related to slag composition and how slag composition is related to slag properties.

For factor 7, the relationship between silicon Ca and Al impuruties and slag composition at equilibrium conditions would have been known to one of skill in the art as shown by the exhibits and affidavit of Dr. Dosaj. Therefore, one skilled in the art would have known how to determine slag composition from the Al and Ca impurities. Further, based upon the exhibits, one skilled in the art would also know how to predict the slag properties from the slag composition. Thus, one skilled in the art would have known how to obtain the slag properties of the examples. Therefore, the examples demonstrate how to select a silicon metalloid based upon the slag properties predicted, and one skilled in the art would have recognized this and understood the examples.

Finally, with respect to factor 8, one skilled in the art would not be required to conduct undue experimentation to conduct the process of the invention. From the affidavit of Dr. Dosaj, the data and calculations for determining slag composition and properties were published and would have been available and apparent to one skilled in the art. Because of these publications and data, one skilled in the art would not be required to perform undue experimentation to conduct the process of the invention.

Therefore, the applicants request that the rejection under 35 U.S.C. §112, first paragraph, be withdrawn and the claims allowed to issue.

The examiner rejected claim 10 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicants regard as their invention because the limitation "for use in the direct process" in line 8 has insufficient antecedent basis. In response, the applicant has amended claim 10 to substitute an indefinite article for the definite article so the claim limitation in claim 10 becomes "for use in a direct process". For this reason, the applicants believe that they have particularly pointed out and distinctly claimed the subject matter that they regard as their invention. Therefore, the applicants request that the rejection under 35 U.S.C. §112, second paragraph, be withdrawn and the claims allowed to issue.

The examiner rejected claims 1, 2, 5, 7 and 8 under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. In response, applicant has amended claim 1 to include the limitation "and using the selected chemical grade silicon metalloid in the direct process for making organohalosilanes". Applicants believe this satisfies the requirement of a physical transformation as outlined by the examiner. Therefore, for this reason, applicant believes claims 1, 2, 5, 7, and 8 are now directed to statutory subject matter and requests that the rejection under 35 U.S.C. 101 be withdrawn and the claims allowed to issue.

Respectfully Submitted,
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